BRIEFER ARTICLES

ON THE CONTENTS OF THE POLLEN CHAMBER OF A SPECIMEN OF *LAGENOSTOMA OVOIDES*

(WITH TWO FIGURES)

Lagenostoma ovoides is one of the commonest of the ovules occurring in the calcite nodules of the British Coal-measures. It is only specifically distinct from *L. Lomaxi*, which has been attributed by OLIVER and SCOTT[1] to *Lyginodendron Oldhamium*. It appears therefore probable that it belongs to one species of the wide group included under that name, and thus is the ovule of a pteridosperm.

In an oblique section through the micropyle and pollen chamber of a specimen of this ovule, sent me some years ago by Mr. LOMAX, I detected, besides the pollen grains which he recorded, several naked protoplasmic bodies of very characteristic form. One of these bodies is within one of the pollen grains, two are free and entire, and one is cut across. Protruding from three of the grains, which show a considerably ruptured epispore, are bladder-like structures which are clearly surrounded by the endospore. Thus I interpreted the grains as germinating, and (as I mentioned in a paper[2] I was writing at the time) "apparently in the very act of yielding antherozoids like those of Cycas and Ginkgo" (p. 168).

The slide was last year exhibited at the Linnaean Society's rooms, London, on the occasion of the celebration of the bicentenary of the birth of LINNAEUS, and my interpretation having met with general acceptance, I have decided that it should be figured. The many valuable contributions to our knowledge of spermatogenesis (including the recent work on Microcycas by CALDWELL[3]) that have appeared in the BOTANICAL GAZETTE, have induced me to send the account of this remarkable fossil to the same journal.

[1] OLIVER, F. W., and SCOTT, D. H., On the structure of the palaeozoic seed *Lagenostoma Lomaxi*. Phil. Trans. Roy. Soc. London B **197**:193–247. *pls. 4–10.* 1904.

[2] BENSON, MARGARET, *Telangium Scotti*, a new species of Telangium (Calymmatotheca) showing structure. Annals of Botany **18**:161–177. *pl. 11.* 1904.

[3] CALDWELL, OTIS W., *Microcycas calocoma*. BOT. GAZETTE **44**:118–141. *figs. 14.* 1907.

The pollen grains in their enlarged state, owing to germination, measure 70×50 μ.[4] The walls are reticulately thickened and the thinner areolae have in many cases given way and become perforations. The protruding endospore can be seen in two cases to contain cells (*fig. 2, t*), but their nature is difficult to determine. They are probably of the same nature as the cells that can be seen attached to one of the free antherozoids (*fig. 2, t*[1]).

In the absence of any evidence as to their nature, I think it best to suggest that they are possibly of fungal origin, but, on the other hand, they

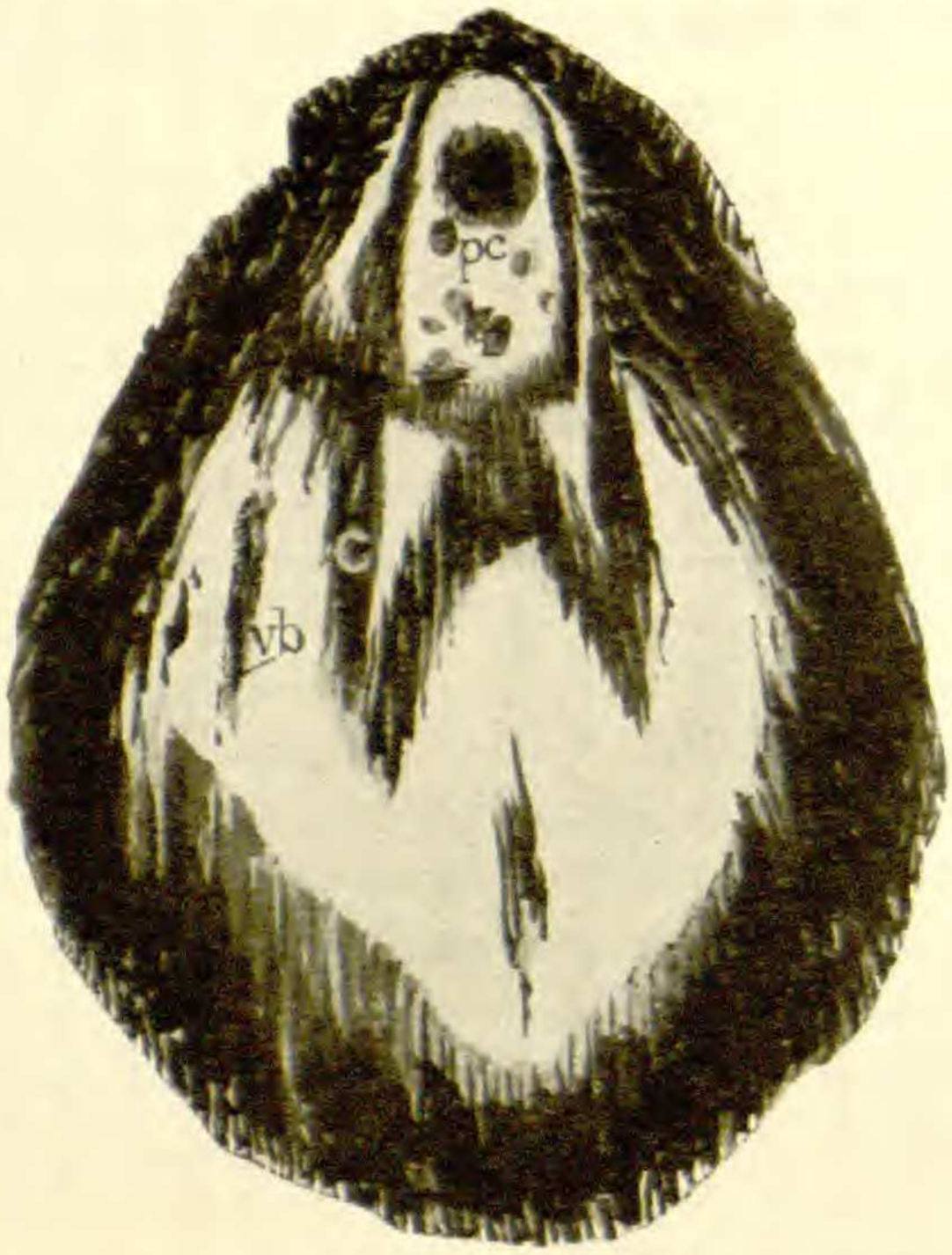

FIG. 1

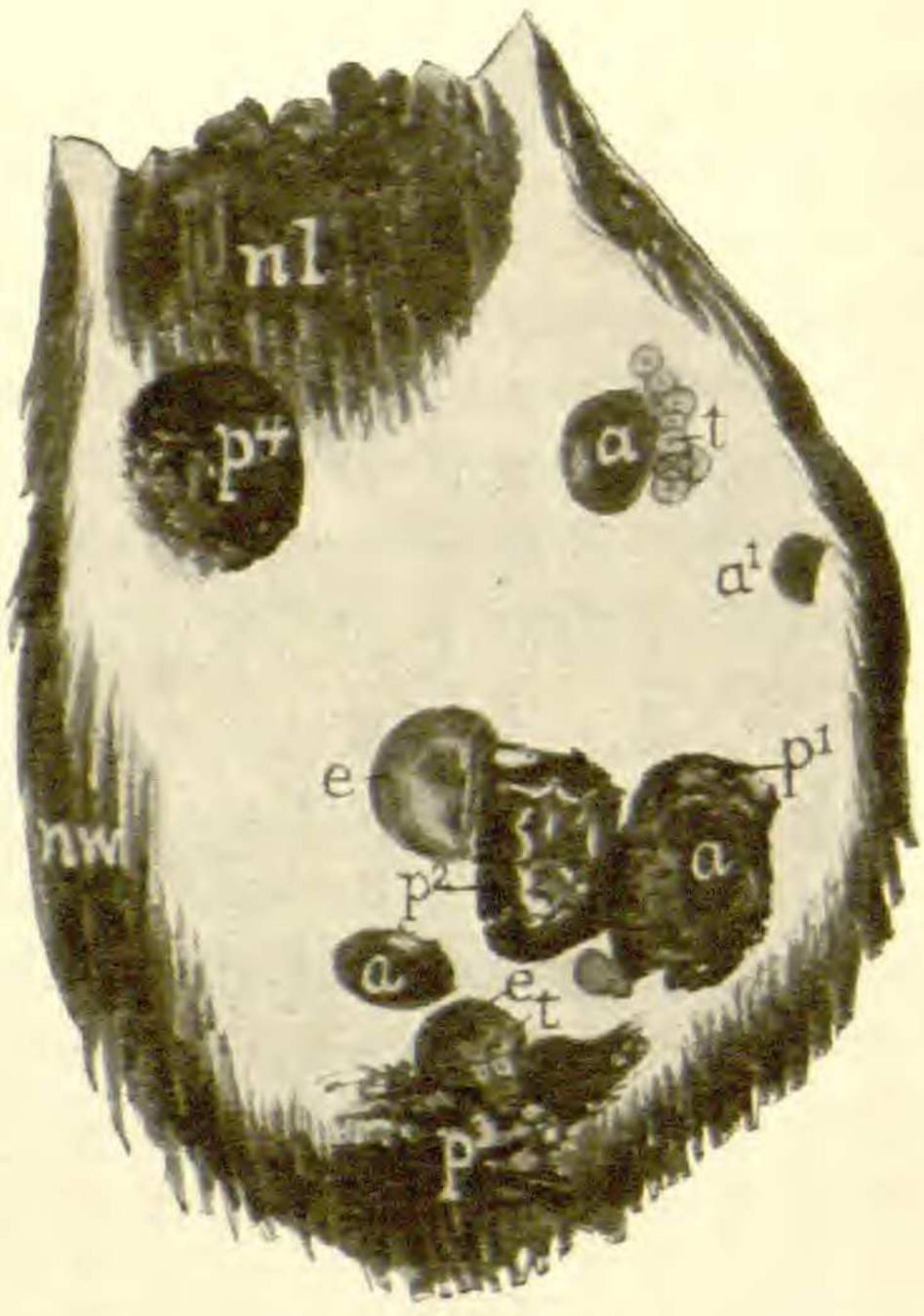

FIG. 2

FIG. 1.—An oblique section through the upper part of the ovule *Lagenostoma ovoides*, ×54; *pc*, pollen chamber; *c*, canopy or inner integument; *vb*, one of the vascular bundles of the integument.

FIG. 2.—The pollen chamber and its contents from the same ovule, ×232; *nl*, tongue of nucellar tissue which supports the pollen chamber; *nw*, nucellar wall of the pollen chamber; *a*, antherozoid; a^1, same cut across; *e*, endospore protrusion; p^1, p^2, p^3, p^4, four pollen grains; *t*, t^1, tissue which is possibly fungal.

Camera drawings from a slide in the R. H. College Collection, C. N. 63. Locality, Dulesgate.

bear a remarkable resemblance to the tissue observed by RENAULT in the pollen grains of Cordaites. If we had a case in which each of these cells gave rise to an antherozoid, it would then be obvious that they were gametophytic. The central body in each cell has the appearance of a nucleus, but is possibly merely the carbonized remains of the whole protoplast.

[4] By an oversight the dimensions were given ten times too small in BENSON, *loc. cit.*

The antherozoids measure 41μ across when free. They are thus about two-thirds the size of those of Microcycas, which appear from CALDWELL'S drawings (*loc. cit.*) to measure 60μ across. Again, they are but one-sixth the size of those of Zamia as figured by WEBBER.[5]

That the antherozoids should be of smaller size than those of recent cycads is explicable when one considers the primitive nature of Lyginodendron and how many fern characteristics it retained. Moreover, there is considerable probability that the number of antherozoids produced by one pollen grain was not limited to two, although there is no evidence as to how many were produced. It is obvious, however, that this pteridosperm did not produce as many as CALDWELL has shown is the case with Microcycas.

Turning now to the figure (*fig. 2*), we see that the pollen chamber is bounded by a thin wall of elongated cells of nucellar origin (*nw*), and that the tongue of nucellar tissue characteristic of the Lagenostoma type of ovule is cut obliquely at *nl*. Within the space thus delimited lie the remains of four pollen grains (p^1, p^2, p^3, p^4). Of these p^1 still contains one antherozoid, and shows but little protrusion of endospore. The grain p^2 is empty; its epispore shows thin areolae, and at *e* the endospore has protruded and shows very faintly one hexagonal cell still preserved near its base. The grain p^3, at the bottom of the exposed part of the pollen chamber, shows clearly five hexagonal cells (*t*), each with a central black spot. The grain has been injured and its contents cannot be determined. Between the grains p^2 and p^3 lies one of the bodies I interpret as antherozoids. The hyaline area of this body appears to correspond with the apex of the coil, but cilia cannot be demonstrated.

A similar body appears on the right near the upper part of the pollen chamber, and this also shows a hyaline area. Accompanying this gamete are the problematical cells which apparently form a continuous tissue and therefore are not chytridiaceous. There are no fungal hyphae connected with them and each cell contains a minute central body. Not far off lies part of a fourth antherozoid (*fig. 2*, a^1), which has evidently been cut across in the process of making the slide.

CONCLUSION

That such bodies as pteridospermous antherozoids should be preserved in the calcite nodules of the Carboniferous rocks will not appear incredible to those who are familiar with the results of palaeobotanical research. In

[5] WEBBER, H. J., Spermatogenesis and fecundation of Zamia. U. S. Dep. Agric., Bur. Pl. Ind., Bull. 2. pp. 100. *pls.* 7. 1901.

the silicified form we have had many records of archegonia from BRONGNIART[6] and RENAULT.[7] The latter devoted considerable time and attention to palaeozoic bacteria, and was the first to record tissue formation in a pollen grain. In calcified material archegonia are found preserved in the megaspores of the Lepidodendreae, and recently SCOTT[8] has recorded the early stages in the germination of fern spores. Still more recently I have had occasion to record a very early stage in the development of the embryo sac in the young megasporangium of Miadesmia.[9] But even with instances such as these, we should not have ventured to identify these antherozoids if it had not been for the antecedent discovery in Ginkgo and the cycads of this type of male gamete. As students of phylogeny, we may well congratulate ourselves that such forms as *Ginkgo biloba* and *Microcycas calocoma* persist to the present time to interpret to us the elaborate pollen chambers of the palaeozoic era. In their turn these paleozoic structures are now giving us some evidence of the great antiquity of the cycad type of male gamete.—MARGARET BENSON, *Royal Holloway College, London University.*

THE EMBRYO OF CERATOZAMIA: A PHYSIOLOGICAL STUDY

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY **111**

(WITH SEVEN FIGURES)

Ceratozamia is a genus of cycads of the American tropics. Its habit and habitat and the manner in which the ovules are shed shortly after fertilization are described by CHAMBERLAIN (**1**) in his preliminary note to the study of the reproductive structures.

The embryo has only one cotyledon. This fact was observed by VAN TIEGHEM (**2**) as early as 1873 in a form which he considered a hybrid between *C. longifolia* and *C. mexicana*, but which was probably pure *C. longifolia*. In 1878 WARMING (**3**) recorded the monocotyledonous condition of the embryo of *C. mexicana*, adding that the cotyledon arises at one side of the hypocotyl axis and little by little comes to surround it.

Being engaged in an anatomical study of the seedling, the first observation I made was naturally upon this character. In every case in over one

[6] BRONGNIART, A., Recherches sur les graines fossiles silicifies. Paris. 1881.

[7] RENAULT, B., Flore fossile d'Autun. Paris. 1896.

[8] SCOTT, D. H., The occurrence of germinating spores in *Stauropteris Oldhamia*. New Phytol. **5**:170–172. 1906.

[9] BENSON, MARGARET, *Miadesmia membranacea*, a new paleozoic lycopod with a seed-like structure. Phil. Trans. Roy. Soc. London B **199**:409–425. *pls. 33–37*. 1908.